

$\psi(4415)$

$I^G(J^{PC}) = 0^-(1^- -)$

$\psi(4415)$ MASS

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
4421 ± 4 OUR ESTIMATE			
4415.1± 7.9	¹ ABLIKIM	08D BES2	$e^+e^- \rightarrow$ hadrons
• • • We do not use the following data for averages, fits, limits, etc. • • •			
4412 ± 15	² MO	10 RVUE	$e^+e^- \rightarrow$ hadrons
4411 ± 7	³ PAKHLOVA	08A BELL	$10.6 e^+e^- \rightarrow D^0 D^- \pi^+ \gamma$
4425 ± 6	⁴ SETH	05A RVUE	$e^+e^- \rightarrow$ hadrons
4429 ± 9	⁵ SETH	05A RVUE	$e^+e^- \rightarrow$ hadrons
4417 ± 10	BRANDELIK	78C DASP	e^+e^-
4414 ± 7	SIEGRIST	76 MRK1	e^+e^-
1 Reanalysis of data presented in BAI 02C. From a global fit over the center-of-mass energy region 3.7–5.0 GeV covering the $\psi(3770)$, $\psi(4040)$, $\psi(4160)$, and $\psi(4415)$ resonances. Phase angle fixed in the fit to $\delta = (234 \pm 88)^\circ$.			
2 Reanalysis of data presented in BAI 00 and BAI 02C. From a global fit over the center-of-mass energy 3.8–4.8 GeV covering the $\psi(4040)$, $\psi(4160)$ and $\psi(4415)$ resonances and including interference effects.			
3 Systematic uncertainties not estimated.			
4 From a fit to Crystal Ball (OSTERHELD 86) data.			
5 From a fit to BES (BAI 02C) data.			

$\psi(4415)$ WIDTH

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
62 ±20 OUR ESTIMATE			
71.5±19.0	⁶ ABLIKIM	08D BES2	$e^+e^- \rightarrow$ hadrons
• • • We do not use the following data for averages, fits, limits, etc. • • •			
118 ±32	⁷ MO	10 RVUE	$e^+e^- \rightarrow$ hadrons
77 ±20	⁸ PAKHLOVA	08A BELL	$10.6 e^+e^- \rightarrow D^0 D^- \pi^+ \gamma$
119 ±16	⁹ SETH	05A RVUE	$e^+e^- \rightarrow$ hadrons
118 ±35	¹⁰ SETH	05A RVUE	$e^+e^- \rightarrow$ hadrons
66 ±15	BRANDELIK	78C DASP	e^+e^-
33 ±10	SIEGRIST	76 MRK1	e^+e^-
6 Reanalysis of data presented in BAI 02C. From a global fit over the center-of-mass energy region 3.7–5.0 GeV covering the $\psi(3770)$, $\psi(4040)$, $\psi(4160)$, and $\psi(4415)$ resonances. Phase angle fixed in the fit to $\delta = (234 \pm 88)^\circ$.			
7 Reanalysis of data presented in BAI 00 and BAI 02C. From a global fit over the center-of-mass energy 3.8–4.8 GeV covering the $\psi(4040)$, $\psi(4160)$ and $\psi(4415)$ resonances and including interference effects.			
8 Systematic uncertainties not estimated.			
9 From a fit to Crystal Ball (OSTERHELD 86) data.			
10 From a fit to BES (BAI 02C) data.			

$\psi(4415)$ DECAY MODES

Due to the complexity of the $c\bar{c}$ threshold region, in this listing, “seen” (“not seen”) means that a cross section for the mode in question has been measured at effective \sqrt{s} near this particle’s central mass value, more (less) than 2σ above zero, without regard to any peaking behavior in \sqrt{s} or absence thereof. See mode listing(s) for details and references.

Mode	Fraction (Γ_i/Γ)	Confidence level
$\Gamma_1 D\bar{D}$		not seen
$\Gamma_2 D^0\bar{D}^0$		seen
$\Gamma_3 D^+D^-$		seen
$\Gamma_4 D^*\bar{D} + \text{c.c.}$		not seen
$\Gamma_5 D^*(2007)^0\bar{D}^0 + \text{c.c.}$		seen
$\Gamma_6 D^*(2010)^+D^- + \text{c.c.}$		seen
$\Gamma_7 D^*\bar{D}^*$		not seen
$\Gamma_8 D^*(2007)^0\bar{D}^*(2007)^0 + \text{c.c.}$		seen

NODE=M073M

NODE=M073M

→ UNCHECKED ←

OCCUR=2

NODE=M073M;LINKAGE=AB

NODE=M073M;LINKAGE=MO

NODE=M073M;LINKAGE=NS

NODE=M073M;LINKAGE=ST

NODE=M073M;LINKAGE=SE

NODE=M073W

NODE=M073W

→ UNCHECKED ←

OCCUR=2

NODE=M073W;LINKAGE=AB

NODE=M073W;LINKAGE=MO

NODE=M073W;LINKAGE=NS

NODE=M073W;LINKAGE=ST

NODE=M073W;LINKAGE=SE

NODE=M073215;NODE=M073

NODE=M073

DESIG=7;OUR EVAL;→ UNCHECKED ←

DESIG=8

DESIG=9

DESIG=10;OUR EVAL;→ UNCHECKED ←

DESIG=11

DESIG=12

DESIG=13;OUR EVAL;→ UNCHECKED ←

DESIG=14

Γ_9	$D^*(2010)^+ D^*(2010)^- + \text{c.c.}$	seen	
Γ_{10}	$D^0 D^- \pi^+ (\text{excl. } D^*(2007)^0 \bar{D}^0 + \text{c.c.})$	< 2.3 %	90%
Γ_{11}	$D \bar{D}_2^*(2460) \rightarrow D^0 D^- \pi^+ + \text{c.c.}$	(10 ± 4) %	
Γ_{12}	$D^0 D^{*-} \pi^+ + \text{c.c.}$	< 11 %	90%
Γ_{13}	$D_s^+ D_s^-$	not seen	
Γ_{14}	$D_s^{*+} D_s^- + \text{c.c.}$	seen	
Γ_{15}	$D_s^{*+} D_s^{*-}$	not seen	
Γ_{16}	$e^+ e^-$	(9.4 ± 3.2) × 10 ⁻⁶	

$\psi(4415)$ PARTIAL WIDTHS

$\Gamma(e^+ e^-)$	DOCUMENT ID	TECN	COMMENT
VALUE (keV)			
0.58±0.07 OUR ESTIMATE			
0.35±0.12	11 ABLIKIM	08D BES2	$e^+ e^- \rightarrow$ hadrons
• • • We do not use the following data for averages, fits, limits, etc. • • •			
0.4 to 0.8	12 MO	10 RVUE	$e^+ e^- \rightarrow$ hadrons
0.72±0.11	13 SETH	05A RVUE	$e^+ e^- \rightarrow$ hadrons
0.64±0.23	14 SETH	05A RVUE	$e^+ e^- \rightarrow$ hadrons
0.49±0.13	BRANDELIK	78C DASP	$e^+ e^-$
0.44±0.14	SIEGRIST	76 MRK1	$e^+ e^-$
11 Reanalysis of data presented in BAI 02C. From a global fit over the center-of-mass energy region 3.7–5.0 GeV covering the $\psi(3770)$, $\psi(4040)$, $\psi(4160)$, and $\psi(4415)$ resonances. Phase angle fixed in the fit to $\delta = (234 \pm 88)^\circ$.			
12 Reanalysis of data presented in BAI 00 and BAI 02C. From a global fit over the center-of-mass energy 3.8–4.8 GeV covering the $\psi(4040)$, $\psi(4160)$ and $\psi(4415)$ resonances and including interference effects. Four sets of solutions are obtained with the same fit quality, mass and total width, but with different $e^+ e^-$ partial widths. We quote only the range of values.			
13 From a fit to Crystal Ball (OSTERHELD 86) data.			
14 From a fit to BES (BAI 02C) data.			

$\psi(4415)$ BRANCHING RATIOS

$\Gamma(D^0\bar{D}^0)/\Gamma_{\text{total}}$	$DOCUMENT\ ID$	$TECN$	$COMMENT$	Γ_2/Γ
seen	PAKHLOVA	08	BELL $e^+ e^- \rightarrow D^0\bar{D}^0\gamma$	
• • • We do not use the following data for averages, fits, limits, etc. • • •				
not seen	AUBERT	09M	BABR $e^+ e^- \rightarrow D^0\bar{D}^0\gamma$	
$\Gamma(D^+\bar{D}^-)/\Gamma_{\text{total}}$	$DOCUMENT\ ID$	$TECN$	$COMMENT$	Γ_3/Γ
seen	PAKHLOVA	08	BELL $e^+ e^- \rightarrow D^+\bar{D}^-$	
• • • We do not use the following data for averages, fits, limits, etc. • • •				
not seen	AUBERT	09M	BABR $e^+ e^- \rightarrow D^+\bar{D}^-$	
$\Gamma(D\bar{D})/\Gamma(D^*\bar{D}^*)$	$DOCUMENT\ ID$	$TECN$	$COMMENT$	Γ_1/Γ_7
seen	AUBERT	09M	BABR $e^+ e^- \rightarrow \gamma D^{(*)}\bar{D}^{(*)}$	
0.14 ± 0.12 ± 0.03				
$\Gamma(D^*(2007)^0\bar{D}^0 + \text{c.c.})/\Gamma_{\text{total}}$	$DOCUMENT\ ID$	$TECN$	$COMMENT$	Γ_5/Γ
seen	AUBERT	09M	BABR $e^+ e^- \rightarrow D^{*0}\bar{D}^0$	
0.17 ± 0.25 ± 0.03				
$\Gamma(D^*(2010)^+\bar{D}^- + \text{c.c.})/\Gamma_{\text{total}}$	$DOCUMENT\ ID$	$TECN$	$COMMENT$	Γ_6/Γ
seen	AUBERT	09M	BABR $e^+ e^- \rightarrow D^{*+}\bar{D}^-$	
seen	PAKHLOVA	07	BELL $e^+ e^- \rightarrow D^{*+}\bar{D}^-$	
$\Gamma(D^*\bar{D} + \text{c.c.})/\Gamma(D^*\bar{D}^*)$	$DOCUMENT\ ID$	$TECN$	$COMMENT$	Γ_4/Γ
seen	AUBERT	09M	BABR $e^+ e^- \rightarrow \gamma D^{(*)}\bar{D}^{(*)}$	
0.17 ± 0.25 ± 0.03				

$\Gamma(D^*(2007)^0 \bar{D}^*(2007)^0 + \text{c.c.})/\Gamma_{\text{total}}$				Γ_8/Γ	NODE=M073R08 NODE=M073R08
VALUE	DOCUMENT ID	TECN	COMMENT		
seen	AUBERT	09M	BABR	$e^+ e^- \rightarrow D^0 \bar{D}^0 \gamma$	
$\Gamma(D^*(2010)^+ D^*(2010)^- + \text{c.c.})/\Gamma_{\text{total}}$				Γ_9/Γ	
VALUE	DOCUMENT ID	TECN	COMMENT		
seen	AUBERT	09M	BABR	$e^+ e^- \rightarrow D^+ D^- \gamma$	NODE=M073R09 NODE=M073R09
seen	PAKHLOVA	07	BELL	$e^+ e^- \rightarrow D^+ D^- \gamma$	
$\Gamma(D \bar{D}_2^*(2460) \rightarrow D^0 D^- \pi^+ + \text{c.c.})/\Gamma_{\text{total}}$				Γ_{11}/Γ	
VALUE (units 10^{-2})	DOCUMENT ID	TECN	COMMENT		
10.5 ± 2.4 ± 3.8	15 PAKHLOVA	08A	BELL	$10.6 e^+ e^- \rightarrow D^0 D^- \pi^+ \gamma$	NODE=M073R3 NODE=M073R3
15 Using 4421 ± 4 MeV for the mass and 62 ± 20 MeV for the width of $\psi(4415)$.					
$\Gamma(D^0 D^- \pi^+ (\text{excl. } D^*(2007)^0 \bar{D}^0 + \text{c.c.}, D^*(2010)^+ D^- + \text{c.c.}))$				Γ_{10}/Γ_{11}	
$\Gamma(D \bar{D}_2^*(2460) \rightarrow D^0 D^- \pi^+ + \text{c.c.})$				Γ_{10}/Γ_{11}	
VALUE	CL%	DOCUMENT ID	TECN	COMMENT	
<0.22	90	16 PAKHLOVA	08A	BELL	$10.6 e^+ e^- \rightarrow D^0 D^- \pi^+ \gamma$
16 Using 4421 ± 4 MeV for the mass and 62 ± 20 MeV for the width of $\psi(4415)$.					
$\Gamma(D^0 D^{*-} \pi^+ + \text{c.c.})/\Gamma_{\text{total}} \times \Gamma(e^+ e^-)/\Gamma_{\text{total}}$				$\Gamma_{12}/\Gamma \times \Gamma_{16}/\Gamma$	
VALUE	CL%	DOCUMENT ID	TECN	COMMENT	
<0.99 × 10 ⁻⁶	90	17 PAKHLOVA	09	BELL	$e^+ e^- \rightarrow D^0 D^{*-} \pi^+$
17 Using 4421 ± 4 MeV for the mass of $\psi(4415)$.					
$\Gamma(D_s^+ D_s^-)/\Gamma_{\text{total}}$				Γ_{13}/Γ	
VALUE	DOCUMENT ID	TECN	COMMENT		
not seen	PAKHLOVA	11	BELL	$e^+ e^- \rightarrow D_s^+ D_s^- \gamma$	
not seen	DEL-AMO-SA..10N	BABR	$e^+ e^- \rightarrow D_s^+ D_s^- \gamma$		
$\Gamma(D_s^{*+} D_s^{*-} + \text{c.c.})/\Gamma_{\text{total}}$				Γ_{14}/Γ	
VALUE	DOCUMENT ID	TECN	COMMENT		
seen	PAKHLOVA	11	BELL	$e^+ e^- \rightarrow D_s^{*+} D_s^{*-} \gamma$	
seen	DEL-AMO-SA..10N	BABR	$e^+ e^- \rightarrow D_s^{*+} D_s^{*-} \gamma$		
$\Gamma(D_s^{*+} D_s^{*-})/\Gamma_{\text{total}}$				Γ_{15}/Γ	
VALUE	DOCUMENT ID	TECN	COMMENT		
not seen	PAKHLOVA	11	BELL	$e^+ e^- \rightarrow D_s^{*+} D_s^{*-} \gamma$	
not seen	DEL-AMO-SA..10N	BABR	$e^+ e^- \rightarrow D_s^{*+} D_s^{*-} \gamma$		

$\psi(4415)$ REFERENCES

PAKHLOVA	11	PR D83 011101	G. Pakhlova <i>et al.</i>	(BELLE Collab.)
DEL-AMO-SA..10N	PR D82 052004	P. del Amo Sanchez <i>et al.</i>	(BABAR Collab.)	
MO	10	PR D82 077501	X.H. Mo, C.Z. Yuan, P. Wang	(BHEP)
AUBERT	09M	PR D79 092001	B. Aubert <i>et al.</i>	(BABAR Collab.)
PAKHLOVA	09	PR D80 091101	G. Pakhlova <i>et al.</i>	(BELLE Collab.)
ABLIKIM	08D	PL B660 315	M. Ablikim <i>et al.</i>	(BES Collab.)
PAKHLOVA	08	PR D77 011103	G. Pakhlova <i>et al.</i>	(BELLE Collab.)
PAKHLOVA	08A	PRL 100 062001	G. Pakhlova <i>et al.</i>	(BELLE Collab.)
PAKHLOVA	07	PRL 98 092001	G. Pakhlova <i>et al.</i>	(BELLE Collab.)
SETH	05A	PR D72 017501	K.K. Seth	
BAI	02C	PRL 88 101802	J.Z. Bai <i>et al.</i>	(BES Collab.)
BAI	00	PRL 84 594	J.Z. Bai <i>et al.</i>	(BES Collab.)
OSTERHELD	86	SLAC-PUB-4160	A. Osterheld <i>et al.</i>	(SLAC Crystal Ball Collab.)
BRANDELIK	78C	PL 76B 361	R. Brandelik <i>et al.</i>	(DASP Collab.)
SIEGRIST	76	PRL 36 700	J.L. Siegrist <i>et al.</i>	(LBL, SLAC)

NODE=M073

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